

MATERIAL AND EQUIPMENT STANDARD

FOR

LPG PRESSURE STORAGE VESSELS AND SPHERES

ORIGINAL EDITION

AUG. 1993

This standard specification is reviewed and updated by the relevant technical committee on Mar. 1999(1) and Feb. 2013(2). The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

Storage Tanks are broad and contain variable types and usages of paramount importance, therefore, a group of Material Standards are prepared to cover the subject. This group includes the following standards:

STANDARD CODE	STANDARD TITLE
<u>IPS-G-ME-100</u>	“General Standard for Atmospheric Above Ground Welded Steel Storage Tanks”
<u>IPS-G-ME-110</u> <u>IPS-M-ME-120</u>	“General Standard for Large Welded Low Pressure Storage Tanks” “Material and Equipment Standard for Aviation Turbine Fuel Storage Tanks”
<u>IPS-M-ME-130</u>	“Material and Equipment Standard for for LPG Pressure Storage Vessels and Spheres”

The requirements given in this Standard Supplement those of ASME pressure vessels code section VIII Division 1, 2011 edition.

For ease of reference, the clause or section numbering of ASME for items supplemented is given at the beginning of each paragraph.

For the purpose of this Standard specification, the following definitions shall hold:

- Sub. (Substitution) :** The ASME Standard clause is substituted by a new clause.
- Del. (Deletion) :** The ASME Standard clause is deleted without any replacement.
- Add. (Addition) :** A new clause with a new number is added.
- Mod. (Modification) :** Part of the ASME Standard clause is modified, and/or a new description and/or condition is added to that clause.

1. SCOPE

1.1 This Material and Equipment Standard covers the minimum requirements for LPG pressure storage vessels and spheres.

Pressure storage, in this Standard, means storage spheres with design pressure above 100 kPa (1 bar) gage. The requirements of this specification apply to both refrigerated and non refrigerated LPG pressure storage spheres.

1.2 This material and equipment standard gives general requirements to be met by a vendor when submitting quotations for and when supplying the material to be incorporated into the pressure storage spheres.

1.3 Furthermore, the terms and conditions laid down in the inquiry and the purchase order and any attachments thereto shall apply.

1.4 It should be noted that when the design and construction of pressure storage spheres are involved, the requirements of Iranian Petroleum Engineering and construction Standards for pressure storage spheres ([IPS-E-ME-130](#) , [IPS-C-ME-130](#)) shall be met.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Mar. 1999. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 71 on Mar. 1999. These modifications are included in the present issue of IPS.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on Feb. 2013. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No. 376 on Feb. 2013. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

API 2510 "Design and Construction of Liquefied Petroleum Gas (LPG) Installations, May 2001"

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

MR-0175/ISO 15156 "Petroleum and Natural Gas Industries - Material for use in H₂S – Containing Environments in Oil and Gas Production"

AWS (AMERICAN WELDING SOCIETY)

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-ME-130	“Engineering Standard for Pressure Storage Spheres”
IPS-C-ME-130	“Construction Standard for Pressure Storage Spheres”
IPS-E-GN-100	“Engineering Standard for Units”

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Section VIII	“Rules for Construction of Pressure Vessels”
Division 1 or 2	
Section II	“Materials”
Section IX	“Welding and Brazing Qualifications”
ASME B1.1	“Unified Inch Screw Threads”
ASME B16.9	“Factory –Made Wrought Butt welding Fittings”
ASME B16.5-2009	“Pipe Flanges and Flanged Fittings”
ASME B31.3-2010	“Process Piping”

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

A578/A578 M	“Standard Specification for Straight – Beam Ultrasonic Examination of Rolled Steel Plates for Special Application”
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ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 6708-1995	“Pipework Components-Definition and Selection of DN (Nominal Size)”
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3. UNITS

International System of Units (SI) in accordance with [IPS-E-GN-100](#) shall be used.

Whenever reference is made to API, ASME or any other standard, equivalent SI Unit System for dimensions, fasteners and flanges shall be substituted.

For pipe size, the international nomenclature "diameter nominal" written as DN 15,25,32,40, etc. has been used in accordance with ISO 6708, 1995, ASME B16.5, 2009 and ASME B 31.3, 2010. Also for pipe flanges, pressure temperature ratings "pressure nominal" written as PN 20, 50, 64, etc. has been used in accordance with the said standards.

4. GENERAL REQUIREMENTS**4.1 Quotation (Add.)**

Refer to Mandatory Appendix 43 of this Standard for general information to be submitted in the quotation.

4.2 Secrecy (Add.)

Refer to Mandatory Appendix 44 of this Standard for secrecy requirements.

5. DESIGN

5.1 Design of pressure storage spheres shall be in accordance with ASME section VIII division 1.

Where justified, pressure storage spheres may be designed according to division 2 of ASME section VIII.

The requirements of Iranian Petroleum Engineering Standard for pressure storage spheres ([IPS-E-ME-130](#)) shall be also met. The followings shall be considered as supplementary:

5.2 (UG 54c Add.)

The pressure retaining parts of sphere and their support columns shall be designed to be filled with water.

6. MATERIAL

6.1 Material selection for pressure storage spheres shall meet the requirements of section II of the ASME boiler and pressure vessel code.

Requirements of API 2510 for pressure storage of LPG spheres shall be met. The followings shall be considered as supplementary:

6.2 (UG-4 Add.)

Low melting point materials of construction such as aluminum and brass, shall not be used for LPG storage spheres.

6.3 (UG-4 Add.)

Low ductility materials such as cast iron, semi killed steel, malleable iron and cast aluminum shall not be used in any pressure retaining accessory parts.

6.4 (UG-4 Add.)

Mill certificates for the following materials shall be submitted for purchaser's approval.

- Shell plates and reinforcing pads.
- Forging materials such as flanges, nozzle/manhole necks.
- Support columns and bracings.
- Pipes and fittings for nozzle necks.
- Welded attachments to pressure retaining parts.
- Bolts and nuts for pressure retaining parts

6.5 (UG 4 Add.)

Pressure retaining materials to be welded shall have the following chemical composition.

Carbon Equivalent (CE): $CE \leq 0.41 \%$

Where: $CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$

6.6 (UG-4 Add.)

Material for pressure retaining parts specified for use in H₂S service, where defined in para. 1.3 of NACE standard MR-0175/ISO 15156, shall be selected in accordance with the said standard.

6.7 (UG-4 Mod.)

Materials of non pressure retaining parts to be welded directly to pressure retaining parts shall be of the same quality material as the pressure retaining parts.

6.8 (UG-44 Add.)

Flange for sphere nozzles and connections shall be a minimum of PN 20 (150#) flange class. All fittings shall have a minimum nominal diameter of DN 20 (¾").

6.9 (UG-12 Add.)

The internal bolts and nuts including U bolts shall be of TP- 405 or 410 stainless steel.

6.10 (UG-8 Add.)

Where connections are made to external piping, the material and all other requirements for nozzles, flanges, bolts, gaskets and pipes shall be met as specified in that piping class.

6.11 (UG-11 Add.)

Manholes and blanked off nozzles shall have gaskets conforming to the piping specification for lines connecting to the storage spheres nozzles, unless otherwise specified.

6.12 (UG-4 Add.)

Materials equivalent to ASTM standard may be used with the prior approval of the purchaser.

6.13 (UG-12 Add.)

Bolting for pressure parts shall be as follows:

6.13.1 Stud bolts shall be threaded full length, be semi finished and conform to ASME class 2A dimensions, and shall have semi finished nuts conforming to ASME heavy nuts having class 2B dimensions.

6.13.2 Bolting shall normally be used in accordance with ASME B1.1, unified screw threads. Nominal size 25 mm and smaller shall be of the coarse thread series, nominal size 28 mm bolts and larger shall be of the 8 thread series.

6.13.3 Nuts shall be double chamfered.

6.14 (UG-44 Add.)

Butt welding fittings shall be seamless, of the same thickness and schedule of the piping, and conform to ASME B16.9.

Socket welding fittings DN 50 (2") or smaller in dia. size, such as elbows, tees, and couplings, shall be of forged steel and shall have a working pressure of at least 13.8 MPa (2000 Psi).

7. FABRICATION

7.1 (UG-75 Add.)

Works including welding shall be done, as much as possible, at shop to minimize field assembling work. Adjacent pieces, to be assembled at site, shall be shop fitted, and the match shall be marked to ensure proper site fit up.

7.2 (UG-79 Add.)

Shell plates shall be formed with accurate dimensions so that they are easily assembled at site. All nozzles and manholes shall be prefabricated and welded to the shell plates concerned at shop.

7.3 (UG-79 Add.)

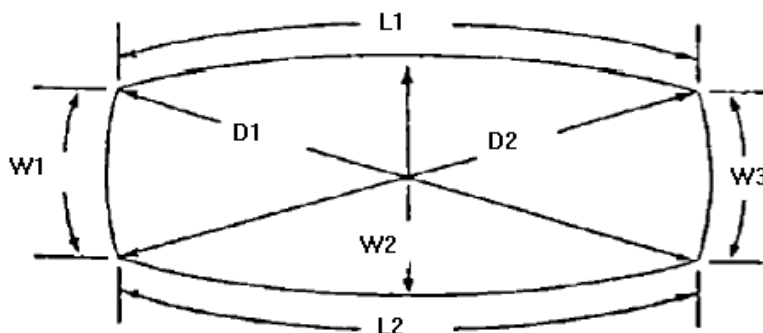
shop fabrication tolerances for the prefabricated sections such as shell plates, support columns, nozzles etc. shall be as follows:

7.3.1 The shell plate thickness after forming shall not be less than the required design thickness by the amount of 0.25 mm or 6% of the design thickness, whichever is smaller.

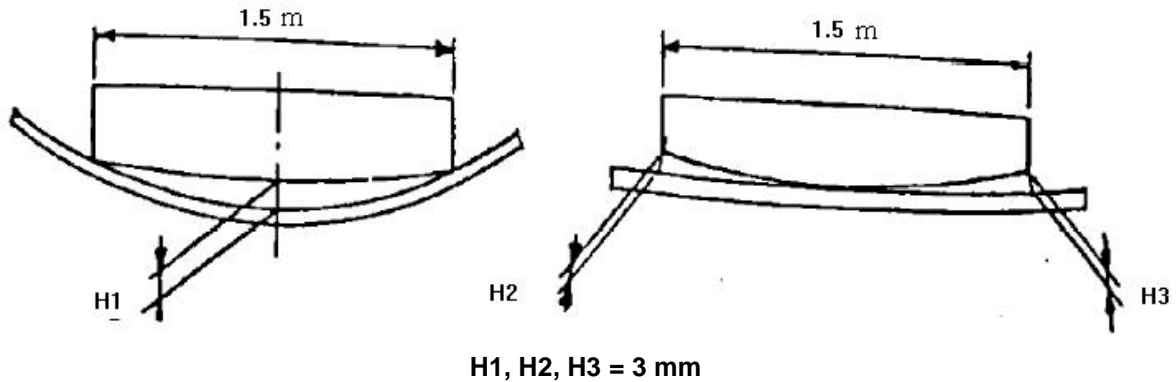
7.3.2 Allowable tolerance for arc length shall be in accordance with Table 1 below:

TABLE 1 - TOLERANCES FOR ARC LENGTH OF SHELL PLATE

MEASURING PORTION	ALLOWABLE TOLERANCES
W_1, W_2, W_3	$\pm 1.5\text{mm}$
L_1, L_2	$\pm 1.5\text{mm}$
$ D1, D2 $	$< 3.9\text{mm}$



7.3.3 The inner surface of formed shell plate shall not deviate more than 3 mm from the specified curvature over a span of 1.5 meter. see Fig. 1 below:



H1, H2, H3 = 3 mm
**PERMISSIBLE DEVIATIONS OF INNER SURFACE
 OF FORMED SHELL PLATES**

Fig. 1

7.3.4 Projection, location and inclination tolerances for flange of nozzles and manholes shall be as shown in Table 2 below:

TABLE 2 - TOLERANCES OF NOZZLES AND MANHOLES

	CONNECTED TO PIPING	NOT CONNECTED TO PIPING
PROJECTION	±6 mm	±25 mm
LOCATION	±15 mm	±25 mm
INCLINATION	±0.5°	±1°

7.3.5 Shop fabrication tolerances for the prefabricated sections other than the above, such as length and bolt circle diameter of support columns etc. shall be submitted for purchaser's approval.

7.4 (UG-82c Add.)

The inner edge of manholes and nozzles shall conform to the sphere inside radius and be smooth without sharp edge.

7.5 (UG-46 Add.)

All reinforcing pads shall be provided with a 6 mm NPT telltale hole which shall be left open.

7.6 (UG-85 Add.)

All flange facing and threaded connections shall be protected against oxidation during heat treatment.

7.7 (UG-75 Add.)

Fabricator shall submit for purchaser's approval the following drawings and documents within the time specified and before start of fabrication.

7.7.1 All shop fabrication drawings.

7.7.2 A general arrangement drawing for each storage vessel and sphere. This drawing shall be to scale and shall show the position of all mountings and accessories required, with reference to the relevant detail drawing (s).

7.7.3 Static calculations for all members of the storage vessel/sphere for which the sizes are not shown on the reference drawings.

7.7.4 In the event that only departure from the reference drawing is proposed with regard to the material to be incorporated, detail drawings showing the proposed changes shall be submitted for

approval.

7.7.5 Detail specification or drawings of any auxiliary materials to be supplied such as pressure and vacuum relieving devices shall be also submitted for approval.

7.7.6 Four number of copies for each drawing for approval shall be submitted. A separate set of drawings for each requisition is required.

8. ERECTION AND PREPARATION FOR SITE ERECTION

8.1 Field erection of pressure storage spheres shall be in accordance with Iranian Petroleum Construction Standard [IPS-C-ME-130](#) "General Requirements for Construction and Field Erection of Pressure Storage Spheres".

8.2 spheres supports shall be fire proofed. The fireproofing encasement shall not, however, cover any portion of the supports at points where they are welded to the shell of the sphere.

8.3 All plates and structural members shall be marked in accordance with a marking diagram to be supplied by the manufacturer which shall also bear such other marks as may be required to facilitate erection.

Erection marks shall be painted clearly on plates and structural members in symbols at least 50 mm high, where practical, and in the case of curved plates, such marks shall be on the inside surface.

When required, erection marks may be hard stamped in symbols not less than 13 mm high which in the case of plates shall be in the corner approximately 150 mm from either edge.

9. WELDING

9.1 Qualification for welding procedures, welders and welding operators shall be in accordance with the requirements of ASME code section IX.

9.2 Welding on pressure storage sphere shall be in accordance with subsection "B" part UW of the ASME pressure vessel code section VIII division I.

9.3 (UW-28a Mod.)

Fabricator shall submit to the purchaser his welding procedure specification and welders qualification test records for approval prior to start of fabrication.

9.4 (UW-28 Add.)

All welding procedures submitted shall be identified with the specific item and purchase order numbers.

9.5 (UW-26 Add.)

Fabricator shall submit for purchaser's approval prior to material supply, his weld preparation procedure including details of beveled plates to be supplied. This shall also conform to ASME section VIII division I.

9.6 (UW-26 Add.)

Fabricator shall show on a drawing the applicable welding procedure and non destructive tests required.

9.7 (UW-37 Add.)

Tack welds shall be made with the same type of electrode that is used for depositing the root pass.

9.8 (UW-35 Add.)

Full penetration welding with full fusion shall be required for all pressure retaining parts including non pressure retaining parts to be welded to pressure retaining parts. All nozzles and manholes

shall be attached to the shell by full penetration welds. Fillet welding is acceptable for the outside circle of reinforcing plates.

9.9 (UW-14 Mod.)

All shell plate seams shall be cleared from nozzles, clips and other external parts by a minimum of 50 mm.

9.10 (UW-33 Add.)

Joints between plates in different thicknesses for shell plates shall be aligned at the inside surfaces.

9.11 (UW-39 Add.)

Welding sequence shall be established in order to perform a deliberate welding to minimize welding stresses.

9.12 (UW-5 Add.)

Welding electrode shall be of AWS approved quality or equivalent. Welding electrodes for use with carbon steels shall be "low hydrogen" type.

9.13 (UW-9 Add.)

All joints between shell plates shall be of double butt welded type with full penetration and complete fusion.

9.14 (UW-27 Add.)

Single pass submerged arc welding through the full thickness of the material from one side only is not permitted.

9.15 (UW-31 Add.)

Where more than one shell ring is required, longitudinal joints shall be staggered to allow at least 60° between longitudinal joints in adjacent sections. Where the orientation of shell connections will not permit this spacing to be maintained, fabricators drawings shall show proposed location of longitudinal seams for the purchaser's consideration and approval. Openings shall not be placed in weld seams insofar as it is practical and economical.

9.16 (UW-37 Add.)

Tolerance for the groove angle shall be within $\pm 5^\circ$ and tolerance for the root opening shall be within ± 1 mm.

9.17 (UW-33 Add.)

Misalignment of sphere shell plates at edges to be butt welded shall be as per applicable code, but it shall not exceed 3.2 mm for longitudinal joints and 4.8 mm for circumferential joints.

9.18 (UW-21 Add.) Slip on flanges should be avoided. If they are used, they shall be welded both inside and outside.

10. INSPECTION AND TEST

10.1 Shop inspection and testing of pressure storage spheres shall be performed in accordance with the requirements of ASME code section VIII division I and the following requirements.

10.2 (UG-90 Mod.)

When the code symbols stamping is not required to the spheres, the items of inspection and testing are considered to be the same as the items of inspection and testing specified in the code to be performed by the manufacturer as the case of code symbol stamping required.

10.3 (UG-93 Add.)

The material inspection shall be performed to confirm the material certificates or mill test reports of the materials as specified in para. 6.4 of this Standard.

10.4 (UG-93 Add.)

Where wet H₂S service is specified, all plate materials to be used for pressure retaining parts shall be subjected to an ultrasonic examination. The method and acceptance standard of ultrasonic examination for the plates material to be used for the spheres shall be in accordance with ASTM standard A578, acceptance (level 1).

10.5 (UG-103 Add.)

The radiographic examination shall be carried out before postweld heat treatment, if any, except where the code specifies that the examination is to be performed after heat treatment.

10.6 Hardness test shall be made on the weld metal and heat affected zone for the following cases:

- a) When specified ultimate tensile strength of shell plate is 490 MPa and over.
- b) Where wet H₂S service is specified.

Hardness test shall be performed after postweld heat treatment where this is to be conducted.

10.7 (UW-46 Add.)

All welding joints of pressure retaining parts and non pressure retaining parts shall be visually inspected to confirm that there are no injurious defects in the weldments.

10.8 (UG-37 Add.)

Weld joints of reinforcing pad for opening shall be leak tested by pneumatic pressure. The test shall be preferably performed at 98 kPa minimum using compressed air.

The test shall be carried out before postweld heat treatment where this is to be conducted.

10.9 (UG-96 a Mod.)

After completion of prefabricated sphere sections, dimensional Inspection shall be made to assure that the tolerances are within the permissible ranges specified in the applicable code and in this Standard specification.

10.10 (UG-90 b Mod.)

It shall be the responsibility of the fabricator to maintain adequate inspection in his own or his sub contractor's works to ensure that the requirements of the specified inspection and test are met.

Purchaser however reserves the right of access at all times to monitor or complement any such inspection.

11. SUPPLEMENTARY REQUIREMENTS (UG-120 Add)

11.1 Vendor shall send final issues of all drawings mentioned under 7.7 together with dispatch lists of materials to the purchaser, the same number of copies as stated in 7.7.7 is required.

11.2 All drawings etc. mentioned under 7.7 and 11.1 will, in every respect, be the property of purchaser who shall have the right to use and reuse them for any purpose whatsoever without any obligation to vendor.

11.3 Papers used for drawings and prints shall be suitable for the purpose, according to TAPPI TIP 0404-36-04, Paper Grade Classification, or, as approved by the Company.

TAPPI: Technical Association of the Pulp and Paper Industry

12. GUARANTEE (Add.)

12.1 Reference is made to Mandatory Appendix 45 of this Standard for guarantee requirements.

APPENDICES**MANDATORY APPENDIX 43 (Add.)****QUOTATION**

A.1 The following information shall be submitted in the quotation:

A.1.1 Price.

A.1.2 Estimated total shipping weight of materials for each sphere with accessories.

A.1.3 Delivery time of the materials.

A.1.4 Steel grades offered.

A.1.5 Plate thicknesses.

A.1.6 Any deviations or exclusions from the stipulations referred to in this specifications if no deviations or exclusions are mentioned in the quotation, it will be deemed to be fully in compliance with said stipulations.

Vendor is free to offer as an alternative, before the purchase order is placed, deviations from the required standards, if these result in a reduction in costs.

A.1.7 The names of subcontractors, if any for the fabrication or any part thereof. Such subcontractors shall be subject to acceptance by purchaser.

A.2 Any purchase order will be subject to all terms, conditions, etc. forming part of the inquiry and any agreed amendments to it.

MANDATORY APPENDIX 44 (Add.)**SECRECY**

Vendor shall not disclose or issue to third parties without the written consent of purchaser any documents, etc. placed at his disposal by purchaser or any documents prepared by himself in connection with inquiries and purchase orders for purposes other than the preparation of a quotation or carrying out such purchase orders.

**MANDATORY APPENDIX 45 (Add.)
GUARANTEE**

C.1 Vendor shall guarantee that the materials delivered to be incorporated into pressure storage sphere(s) are in accordance with the purchase order and will be free from any defects in design, workmanship and material and that they will give proper service under the operating and design conditions as specified, for a period of 18 months, reckoned from the day on which the sphere(s) are delivered.

C.2 The period of 18 months specified above shall be extended by any period(s) during which the spheres after delivery are out of action as a result of any defect covered by this guarantee.

C.3 In the event of defects covered by this guarantee purchaser shall notify vendor as soon as possible and vendor shall without delay remedy or repair free of charge (cost of labor and transportation not excluded) the spheres having such defects, or authorize purchaser to do so. In the latter event vendor shall reimburse to purchaser the actual out of pocket costs, excluding overheads and similar administrative costs.

C.4 Remedying and repairing may be effected by purchaser without prior approval by vendor in cases where it would be unreasonable to demand that prior approval be obtained. In such cases vendor and purchaser shall agree which party shall bear the costs and expenses there of or in what proportion these costs and expenses shall be divided between them. This guarantee shall remain in effect, provided the remedying and repairing do not result in any detriment to the sphere(s).

C.5 In no event will this guarantee cover defect due to normal wear and tear, disregard by purchaser or his consignee of operating instructions, excessive over loading by purchaser or his consignee or unsuitable operating conditions.